Ecological Soil Screening Levels for Chromium

Interim Final

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U.S. Environmental Protection Agency
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</tr>
</thead>
<tbody>
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</tr>
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<td>Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Trivalent Chromium</td>
</tr>
<tr>
<td>Appendix 6-2</td>
<td>Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Hexavalent Chromium</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

Ecological Soil Screening Levels (Eco-SSLs) are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds, and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs are derived to be protective of the conservative end of the exposure and effects species distribution, and are intended to be applied at the screening stage of an ecological risk assessment. These screening levels should be used to identify the contaminants of potential concern (COPCs) that require further evaluation in the site-specific baseline ecological risk assessment that is completed according to specific guidance (U.S. EPA, 1997, 1998, and 1999). The Eco-SSLs are not designed to be used as cleanup levels and the United States (U.S.) Environmental Protection Agency (EPA) emphasizes that it would be inappropriate to adopt or modify the intended use of these Eco-SSLs as national cleanup standards.

The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003). The derivation procedures represent the collaborative effort of a multi-stakeholder team consisting of federal, state, consulting, industry, and academic participants led by the U.S. EPA, Office of Solid Waste and Emergency Response.

This document provides the Eco-SSL values for chromium and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying chromium concentrations in soil that may present an unacceptable ecological risk to terrestrial receptors. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances of the site. EPA may change this guidance in the future, as appropriate. EPA and state personnel may use and accept other technically sound approaches, either on their own initiative, or at the suggestion of potentially responsible parties, or other interested parties. Therefore, interested parties are free to raise questions and objections about the substance of this document and the appropriateness of the application of this document to a particular situation. EPA welcomes public comments on this document at any time and may consider such comments in future revisions of this document.

2.0 SUMMARY OF ECO-SSLs FOR CHROMIUM

Chromium is the 21st most common element in the earth’s crust. Chromium ore deposits are primarily used for metallurgical applications such as the production of stainless steel. Other uses include wood preservation, leather tanning, pigments, and refractories (Barnhardt, 1997). In the natural environment, chromium occurs as two oxidation states or valences: chromium (III) and chromium (VI).
Chromium speciation in soils is complex. Among the factors that affect the speciation of chromium in soil and water and its uptake into animals and plants include: organic matter content, ferrous ion content, redox state, and pH (Outridge and Scheuhammer, 1993; CCME, 1996). In general, chromium (VI) is favored by higher pH, aerobic conditions, low amounts of organic matter and the presence of manganese and iron oxides which oxidize chromium (III). Transformation of chromium (VI) to the trivalent form tends to occur in acidic, anoxic soils with high organic content. Chromium (III) is cationic and adsorbs onto clay particles, organic matter, metal oxyhydroxides, and other negatively charged particles in contrast to chromium (VI) which does not interact significantly with clay or organic matter. As a result, chromium (VI) is more water-soluble and mobile than chromium (III) (Outridge and Scheuhammer, 1993).

Plants are reported to play a major role in the geochemistry of chromium as they contain a significant fraction of the biologically active pool of chromium, approximately three orders of magnitude greater than that found in animal tissues. In contrast to animals, chromium (III) uptake by plants occurs more rapidly than chromium (VI). It is uncertain, however, if chromium is an essential element for plant nutrition although some investigators have observed a stimulatory effect of chromium on plant growth (Outridge and Scheuhammer, 1993).

Chromium has, however, been shown to be an essential nutrient for humans and animals (NRC, 1997). Several reviews are available concerning its role in nutrition (Anderson, 1987; Anderson, 1988; Borel and Anderson, 1984; Prasad, 1978; Underwood, 1977). Chromium (III) has been shown to have antioxidative properties in vivo and it is integral in activating enzymes and maintaining the stability of proteins and nucleic acids. Its primarily metabolic role is to potentiate the action of insulin through its presence in an organometallic molecule called the glucose tolerance factor (GTF).

The hexavalent forms of chromium are absorbed three to five times better in the intestine compared to chromium (III) forms. Some evidence suggests that ingested orally, most of the chromium (VI) is believed to be reduced to chromium (III) before reaching sites of absorption in the small intestine (Outridge and Scheuhammer, 1993). Anionic forms of both chromium (III) and chromium (VI) are absorbed more rapidly than the cationic forms (Eastin et al., 1980). Chromium in synthetic organic forms is more readily absorbed and accumulated into tissues compared to the inorganic forms of chromium (NRC, 1997). Chromium toxicosis in ruminants is associated with severe congestion and inflammation of the digestive tract, and kidney and liver damage, with the precipitating properties of chromium believed to be the basis of the tissue damage (Thompson et al., 1991).

The Eco-SSL values derived to date for chromium are summarized in Table 2.1.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Soil Invertebrates</th>
<th>Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enough data to derive Eco-SSL.</td>
<td>Not enough data to derive Eco-SSL.</td>
<td>Avian: Cr III - 26, Cr VI - NA; Mammalian: Cr III - 34, Cr VI - 130</td>
</tr>
</tbody>
</table>
Eco-SSL values for trivalent chromium were derived for avian and mammalian wildlife. Eco-SSL values for hexavalent chromium were derived for mammalian wildlife. Data were insufficient to derive Eco-SSLs for plants or soil invertebrates. The Eco-SSLs for trivalent chromium range from 26 mg/kg dry weight (dw) for birds to 34 mg/kg dw for mammals. The Eco-SSL for hexavalent chromium for mammals is equal to 130 mg/kg dw. The Eco-SSL values are lower than the 50th percentile of reported background concentrations for both eastern and western U.S. soils (Figure 2.1). Background concentrations reported for many metals in U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003).

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 150 were selected for acquisition for further review. Of those papers acquired, 11 met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Thirteen studies received an Evaluation Score greater than ten. These studies are listed in Table 3.1. An Eco-SSL for terrestrial plants could not be calculated from these studies as the endpoints are not acceptable for Eco-SSL derivation (U.S. EPA, 2003). The endpoints are either unbounded values, or EC$_{50}$ values (concentration adversely affecting 50% of the test population) or values that could not be determined.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 31 were selected for acquisition for further review. Of those papers acquired, 4 met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Two studies received an Evaluation Score greater than ten. These studies are listed in Table 4.1. There are only two studies eligible for Eco-SSL derivation. At least three studies are required to derive an Eco-SSL for soil invertebrates (U.S. EPA, 2003; Attachment 3-2). An Eco-SSL for soil invertebrates could not be calculated for chromium.
<table>
<thead>
<tr>
<th>Reference</th>
<th>IP Number</th>
<th>Study ID</th>
<th>Test Organism</th>
<th>Soil pH</th>
<th>OM%</th>
<th>Bio-availability Score</th>
<th>ERE</th>
<th>Tox Parameter</th>
<th>Tox Value (Soil Conc mg/kg dw)</th>
<th>Total Evaluation Score</th>
<th>Eligible for Eco-SSL Derivation?</th>
<th>Used for Eco-SSL?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adema and Henzen, 1989</td>
<td>2125</td>
<td>a</td>
<td>Oat</td>
<td>5.1</td>
<td>3.7</td>
<td>2</td>
<td>GRO</td>
<td>NOAEC</td>
<td>21</td>
<td>13</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Adema and Henzen, 1989</td>
<td>2125</td>
<td>b</td>
<td>Tomato</td>
<td>5.1</td>
<td>3.7</td>
<td>2</td>
<td>GRO</td>
<td>NOAEC</td>
<td>20</td>
<td>13</td>
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<td>N</td>
</tr>
<tr>
<td>Adema and Henzen, 1989</td>
<td>2125</td>
<td>c</td>
<td>Lettuce</td>
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<td>3.7</td>
<td>2</td>
<td>GRO</td>
<td>cnbd</td>
<td>cnbd</td>
<td>13</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Adema and Henzen, 1989</td>
<td>2125</td>
<td>d</td>
<td>Oat</td>
<td>7.5</td>
<td>1.4</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>24</td>
<td>13</td>
<td>N</td>
<td>N</td>
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<td>Adema and Henzen, 1989</td>
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<td>e</td>
<td>Tomato</td>
<td>7.5</td>
<td>1.4</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>23</td>
<td>13</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Adema and Henzen, 1989</td>
<td>2125</td>
<td>f</td>
<td>Lettuce</td>
<td>7.5</td>
<td>1.4</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>20.4</td>
<td>13</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Gunther and Pestemer, 1990</td>
<td>7099</td>
<td>a</td>
<td>Oat</td>
<td>6.1</td>
<td>2.2</td>
<td>1</td>
<td>GRO</td>
<td>EC50</td>
<td>9</td>
<td>14</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Gunther and Pestemer, 1990</td>
<td>7099</td>
<td>b</td>
<td>Turnip</td>
<td>6.1</td>
<td>2.2</td>
<td>1</td>
<td>GRO</td>
<td>EC50</td>
<td>3</td>
<td>14</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Kadar and Morvai, 1998</td>
<td>12988</td>
<td>a</td>
<td>Carrot</td>
<td>7.0</td>
<td>1.0</td>
<td>1</td>
<td>GRO</td>
<td>LOAEC</td>
<td>15</td>
<td>11</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Kadar and Morvai, 1998</td>
<td>12988</td>
<td>b</td>
<td>Pea</td>
<td>7.0</td>
<td>1.0</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>109</td>
<td>11</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Kadar and Morvai, 1998</td>
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<td>c</td>
<td>Carrot</td>
<td>7.0</td>
<td>1.0</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>138</td>
<td>11</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Kadar and Morvai, 1998</td>
<td>12988</td>
<td>d</td>
<td>Pea</td>
<td>7.0</td>
<td>1.0</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>138</td>
<td>11</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Singh and Jeng, 1993</td>
<td>12400</td>
<td></td>
<td>Ryegrass</td>
<td>5.6</td>
<td>0.7</td>
<td>1</td>
<td>GRO</td>
<td>NOAEC</td>
<td>50</td>
<td>14</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

cnbd = could not be determined  
EC50 = Effect concentration for 50% of test population  
ERE = Ecologically relevant endpoint  
GRO = Growth  
LOAEC = Lowest observed adverse effect concentration  
N = No  
NOAEC = No observed adverse effect concentration  
OM = Organic matter content  
Table 4.1  Invertebrate Toxicity Data - Chromium

<table>
<thead>
<tr>
<th>Reference</th>
<th>IP Number</th>
<th>Study ID</th>
<th>Test Organism</th>
<th>Soil pH</th>
<th>OM%</th>
<th>Bio-availability Score</th>
<th>ERE Parameter</th>
<th>Tox Parameter</th>
<th>Tox Value (Soil Conc. mg/kg dw)</th>
<th>Total Evaluation Score</th>
<th>Eligible for Eco-SSL Derivation?</th>
<th>Used for Eco-SSL?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Gestel et al., 1992</td>
<td>12874</td>
<td>a</td>
<td>Earthworm <em>Eisenia andrei</em></td>
<td>6.7</td>
<td>10.0</td>
<td>1</td>
<td>REP</td>
<td>MATC</td>
<td>57</td>
<td>16</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Van Gestel et al., 1993</td>
<td>6828</td>
<td></td>
<td>Earthworm <em>Eisenia andrei</em></td>
<td>6.0</td>
<td>10.0</td>
<td>1</td>
<td>REP</td>
<td>MATC</td>
<td>57</td>
<td>12</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

ERE = Ecologically relevant endpoint
LOAEC = Lowest observed adverse effect concentration
MATC = Maximum acceptable toxicant concentration = geometric mean of NOAEC and LOAEC
N = No
NOAEC = No observed adverse effect concentration
OM = Organic matter content
REP = Reproduction
Y = Yes
Bioavailability Score described in *Guidance for Developing Eco-SSLs* (USEPA, 2003)
Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (USEPA, 2003)
5.0 ECO-SSL FOR AVIAN WILDLIFE

The derivation of the Eco-SSL for avian wildlife was completed as two parts. First, the toxicity reference value (TRV) was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species based on the wildlife exposure model (USEPA, 2003; Attachment 4-1), and the TRV (U.S. EPA, 2003).

5.1 Avian TRV

The literature search completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) identified 704 papers with possible toxicity data for chromium for either avian or mammalian species. Of these papers, 649 were rejected for use as described in Section 7.5. Of the remaining papers, 13 contained data for avian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are summarized in Table 5.1 for trivalent chromium. The complete results are included as Appendix 5-1. A TRV could not be derived for hexavalent chromium as there were not enough study results to meet the minimum data requirements. The available hexavalent chromium data extracted and reviewed are included as Appendix 5-2.

Within the reviewed papers, there are 28 results for trivalent chromium for biochemical (BIO), behavior (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) effects that meet the Data Evaluation Score of >65 for use to derive the TRV (U.S. EPA, 2003; Attachment 4-4). These data are plotted in Figure 5.1 and correspond directly with the data presented in Table 5.1. The no-observed adverse effect level (NOAEL) results for growth and reproduction are used to calculate a geometric mean NOAEL. This mean NOAEL is examined in relationship to the lowest bounded lowest-observed adverse effect level (LOAEL) for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth was calculated at 2.66 mg chromium/kg bw/day. This value is lower than the lowest bounded LOAEL for reproduction, growth, or survival (Figure 5.1). Therefore, the TRV is equal to the geometric mean of the NOAEL values for reproduction and growth and is equal to 2.66 mg chromium/kg bw/day.

5.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values were calculated for avian wildlife, one each for three receptor groups representing different trophic levels. The avian Eco-SSLs for trivalent chromium were calculated according to the Eco-SSL guidance (U.S. EPA, 2003) and are summarized in Table 5.2.
### Table 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

#### Trivalent Chromium

<table>
<thead>
<tr>
<th>Result #</th>
<th>Reference</th>
<th>Test Organism</th>
<th>No. of Conc/Doses</th>
<th>Method of Analyses</th>
<th>Route of Exposure</th>
<th>Exposure Duration</th>
<th>Age</th>
<th>Age Units</th>
<th>Effect Type</th>
<th>Effect Measure</th>
<th>Response Site</th>
<th>NOAEL Dose (mg/kg bw/day)</th>
<th>LOAEL Dose (mg/kg bw/day)</th>
<th>Data Evaluation Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jensen and Maurice, 1980</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 4 w</td>
<td>NR LB F CHM GLUC BL</td>
<td>0.494</td>
<td>0.744</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Guerra et al., 2002</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 28 d</td>
<td>32 w JV F ENZ GENZ LI</td>
<td>1.14</td>
<td>2.28</td>
<td>76</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Guerra et al., 2002</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 28 d</td>
<td>32 w JV F ENZ GENZ LI</td>
<td>1.14</td>
<td>2.28</td>
<td>76</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sauveur and Thapon, 1983</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 8 w</td>
<td>40 w AD F FDB FCNS WO</td>
<td>0.0247</td>
<td>0.0247</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hossain et al., 1998</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 19 d</td>
<td>28 w JV B FDB FCNS WO</td>
<td>0.0247</td>
<td>0.0247</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Motozono et al., 1998</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 35 d</td>
<td>7 d JV F FDB FCNS WO</td>
<td>0.483</td>
<td>20.4</td>
<td>69</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Meluzzi et al., 1996</td>
<td>Chicken (Gallus domesticus)</td>
<td>4 U FD 75 d</td>
<td>22 w AD F FDB FCNS WO</td>
<td>0.483</td>
<td>42.4</td>
<td>69</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td>Hossain et al., 1998</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 19 d</td>
<td>28 w JV B FDB FCNS WO</td>
<td>0.0247</td>
<td>0.0247</td>
<td>68</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>Steele and Rosebrough, 1979</td>
<td>Turkey (Meleagris gallopavo)</td>
<td>4 U FD 14 d</td>
<td>1 w JV B FDB FCNS WO</td>
<td>0.0247</td>
<td>1.67</td>
<td>73</td>
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</tr>
<tr>
<td>10</td>
<td>Cupo and Donaldson, 1987</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 21 d</td>
<td>1 w JV M ORW ORWT LI</td>
<td>1.45</td>
<td>1.45</td>
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<td>Jensen and Maurice, 1980</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 4 w</td>
<td>NR LB F REP TPRD WO</td>
<td>0.238</td>
<td>0.744</td>
<td>78</td>
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<td>12</td>
<td>Steele and Rosebrough, 1979</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 12 w</td>
<td>40 w LB F REP TPRD WO</td>
<td>0.483</td>
<td>0.483</td>
<td>70</td>
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<td>13</td>
<td>Jensen and Maurice, 1980</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 4 w</td>
<td>NR LB F REP TPRD WO</td>
<td>0.483</td>
<td>0.483</td>
<td>70</td>
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<td>14</td>
<td>Haseltine et al., unpublished</td>
<td>Black duck (Anas rubripes)</td>
<td>3 U FD 180-190 d</td>
<td>NR LB F REP RSUC WO</td>
<td>0.569</td>
<td>2.78</td>
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<td>Sauveur and Thapon, 1983</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 8 w</td>
<td>40 w LB F REP TPRD WO</td>
<td>0.744</td>
<td>0.744</td>
<td>78</td>
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<td>Ousterhout and Berg, 1981</td>
<td>Chicken (Gallus domesticus)</td>
<td>4 U FD 6 d</td>
<td>50 w LB F EGG ESQU SL</td>
<td>0.988</td>
<td>37.7</td>
<td>75.4</td>
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<td>Meluzzi et al., 1996</td>
<td>Chicken (Gallus domesticus)</td>
<td>4 U FD 15 d</td>
<td>22 w LB F EGG ALWT EG</td>
<td>37.7</td>
<td>75.4</td>
<td>81</td>
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<td>Maurice and Jensen, 1979</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 12 w</td>
<td>40 w SM F GRO BDWT WO</td>
<td>0.483</td>
<td>0.483</td>
<td>68</td>
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<td>19</td>
<td>Cupo and Donaldson, 1987</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 21 d</td>
<td>1 w JV M GRO BDWT WO</td>
<td>1.45</td>
<td>1.45</td>
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<td>20</td>
<td>Steele and Rosebrough, 1979</td>
<td>Turkey (Meleagris gallopavo)</td>
<td>4 U FD 14 d</td>
<td>1 w JV B GRO BDWT WO</td>
<td>6.62</td>
<td>6.62</td>
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<td>21</td>
<td>Hill, 1974</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 2 w</td>
<td>1 d JV B GRO BDWT WO</td>
<td>85.9</td>
<td>85.9</td>
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<td>Hafez and Kratzer, 1976</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 4 w</td>
<td>1 d AD M GRO BDWT WO</td>
<td>359</td>
<td>359</td>
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<td>Motozono et al., 1998</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 35 d</td>
<td>7 d JV F GRO BDWT WO</td>
<td>9.91</td>
<td>9.91</td>
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<td>24</td>
<td>Nielsen et al, 1980</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 4 w</td>
<td>1 d JV M GRO BDWT WO</td>
<td>28.7</td>
<td>28.7</td>
<td>72</td>
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<td>25</td>
<td>Hossain et al., 1998</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 19 d</td>
<td>29 w JV B MOR MORT WO</td>
<td>0.0248</td>
<td>0.0248</td>
<td>79</td>
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<td>26</td>
<td>Haseltine et al., unpublished</td>
<td>Black duck (Anas rubripes)</td>
<td>3 U FD 10 m</td>
<td>NR NR MA F MOR MORT WO</td>
<td>0.557</td>
<td>2.78</td>
<td>77</td>
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<tr>
<td>27</td>
<td>Hill, 1974</td>
<td>Chicken (Gallus domesticus)</td>
<td>2 U FD 5 w</td>
<td>1 d JV F GRO BDWT WO</td>
<td>85.9</td>
<td>85.9</td>
<td>77</td>
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<tr>
<td>28</td>
<td>Hafez and Kratzer, 1976</td>
<td>Chicken (Gallus domesticus)</td>
<td>3 U FD 4 w</td>
<td>1 d AD M MOR MORT WO</td>
<td>359</td>
<td>359</td>
<td>77</td>
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</tbody>
</table>

AD = adult; ALWT = albumin weight; B = both sexes; BDWT = body weight changes; BL = blood; CHM = chemical changes; d = days; EG = egg; EGG = effects on eggs; ENZ = enzyme changes; ESQU = eggshell quality; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; FDCV = feed conversion efficiency; GENZ = general enzyme changes; GLUC = glucose; GRO= growth; JV = juvenile; LB = laying bird; LI = liver; m = months; M = male; MA = mature; MOR = effects on survival; MORT = mortality; NR = not reported; ORW = organ weight changes; ORWT = Organ weight changes; PHY = physiology; REP = reproductive effects; RSUC = reproductive success; SL = spleen; SM = sexually mature; TPRD = total production; U = unmeasured; w = weeks; WO = whole organism.

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**Eco-SSL for Chromium**

7 April 2008
Figure 5.1  Avian TRV Derivation for Trivalent Chromium

**Wildlife TRV Derivation Process**

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.66 mg/kg bw/d and is higher than the lowest bounded LOAEL within the reproduction, growth, and survival effect groups.

5) The avian wildlife TRV for trivalent chromium is equal to 2.66 mg chromium/kg bw/day which is the geometric mean of NOAEL values for growth, and reproduction.
Table 5.2 Calculation of the Avian Eco-SSLs for Trivalent Chromium

<table>
<thead>
<tr>
<th>Surrogate Receptor Group</th>
<th>TRV for Trivalent Chromium (mg dw/kg bw/d)</th>
<th>Food Ingestion Rate (FIR)(^2) (kg dw/kg bw/d)</th>
<th>Soil Ingestion as Proportion of Diet (Ps)(^2)</th>
<th>Concentration of Chromium in Biota Type (i)(^2,3) (Bi) (mg/kg dw)</th>
<th>Eco-SSL (mg/kg dw)(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avian herbivore (dove)</td>
<td>2.66</td>
<td>0.190</td>
<td>0.139</td>
<td>(B_i = 0.041 \times \text{Soil}_i), where i = plants</td>
<td>78</td>
</tr>
<tr>
<td>Avian ground insectivore (woodcock)</td>
<td>2.66</td>
<td>0.214</td>
<td>0.164</td>
<td>(B_i = 0.306 \times \text{Soil}_i), where i = earthworms</td>
<td>26</td>
</tr>
<tr>
<td>Avian carnivore (hawk)</td>
<td>2.66</td>
<td>0.0353</td>
<td>0.057</td>
<td>(\ln(B_i) = 0.7338 \times \ln(\text{Soil}_i) - 1.4599), where i = mammals</td>
<td>780</td>
</tr>
</tbody>
</table>

\(^1\) The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).

\(^2\) Parameters (FIR, Ps, Bi values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).

\(^3\) \(B_i\) = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.

\(^4\) HQ = FIR * (Soil\(_i\) * Ps + Bi) / TRV) solved for HQ=1 where Soil\(_i\) = Eco-SSL (Equation 4-2; U.S. EPA, 2003).

NA = Not Applicable
6.0 ECO-SSL FOR MAMMALIAN WILDLIFE

The derivation of the Eco-SSL for mammalian wildlife was completed as two parts. First, the TRV was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species based on the wildlife exposure model (USEPA, 2003; Attachment 4-1), and the TRV (U.S. EPA, 2003).

6.1 Mammalian TRV

The literature search was completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) and identified 704 papers with possible toxicity data for chromium for either avian or mammalian species. Of these studies, 649 were rejected for use as described in Section 7.5. Of the remaining papers, 20 contained data for mammalian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3). The results of the data extraction and review are summarized in Table 6.1 for trivalent chromium and Table 6.2 for hexavalent chromium. The complete results are provided in Appendices 6-1 and 6-2 for trivalent and hexavalent chromium, respectively.

Within the 20 papers there are 33 results for biochemical (BIO), behavioral (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) endpoints with a total Data Evaluation Score >65 that were used to derive the TRV (U.S. EPA, 2003; Attachment 4-4) for trivalent chromium. These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. There are 71 results for hexavalent chromium. These data are plotted in Figure 6.2 and correspond directly with the data presented in Table 6.2. The NOAEL results for growth and reproduction are used to calculate a geometric mean NOAEL. This mean NOAEL is examined in relationship to the lowest bounded LOAEL for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

For trivalent chromium, a geometric mean of the NOAEL values for reproduction and growth was calculated at 2.40 mg chromium/kg bw/day. There are no bounded LOAEL values for reproduction, growth or mortality results for comparison. Therefore, the TRV is equal to the geometric mean of NOAEL values for reproduction and growth and is equal to 2.40 mg chromium/kg bw/day.

For hexavalent chromium, a geometric mean of the NOAEL values for reproduction and growth was calculated at 9.24 mg chromium/kg bw/day. The geometric mean is lower than the lowest bounded LOAEL value for reproduction, growth and survival results. Therefore, the TRV is equal to the geometric mean of NOAEL values for reproduction and growth and is equal to 9.24 mg chromium/kg bw/day.
<table>
<thead>
<tr>
<th>Result #</th>
<th>Reference</th>
<th>Test Organism</th>
<th>Method of Analyses</th>
<th>Route of Exposure</th>
<th>Exposure Duration</th>
<th>Response Site</th>
<th>Data Evaluation Score</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Samsell and Spears, 1989</td>
<td>Sheep (Ovis aries)</td>
<td>U FD</td>
<td>28 d</td>
<td>9 mo</td>
<td>JV</td>
<td>F</td>
</tr>
<tr>
<td>2</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>103 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
</tr>
<tr>
<td>3</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>35 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
</tr>
<tr>
<td>4</td>
<td>Anderson et al., 1997</td>
<td>Rat (Rattus norvegicus)</td>
<td>U FD</td>
<td>90 d</td>
<td>100 d</td>
<td>SM</td>
<td>F</td>
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<tr>
<td>5</td>
<td>Ivankovic and Preussmann, 1975</td>
<td>Rat (Rattus norvegicus)</td>
<td>U FD</td>
<td>90 d</td>
<td>100 d</td>
<td>SM</td>
<td>F</td>
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<td>6</td>
<td>Meenakshi et al., 1989</td>
<td>Rat (Rattus norvegicus)</td>
<td>U GV</td>
<td>60 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
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<td>7</td>
<td>Cobo et al 1995</td>
<td>Rat (Rattus norvegicus)</td>
<td>U FD</td>
<td>12 w</td>
<td>NR</td>
<td>NR</td>
<td>AD</td>
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<td>Mooney and Cromwell, 1997</td>
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<td>M FD</td>
<td>90 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
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<tr>
<td>9</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>35 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
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<tr>
<td>10</td>
<td>Bataineh et al., 1997</td>
<td>Rat (Rattus norvegicus)</td>
<td>U FD</td>
<td>12 w</td>
<td>NR</td>
<td>NR</td>
<td>AD</td>
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<tr>
<td>11</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>90 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
</tr>
<tr>
<td>12</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>35 d</td>
<td>NR</td>
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<td>Kanisawa and Schroeder, 1969</td>
<td>Rat (Rattus norvegicus)</td>
<td>U FD</td>
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<td>NR</td>
<td>NR</td>
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<td>Bataineh et al., 1997</td>
<td>Rat (Rattus norvegicus)</td>
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<td>Meenakshi et al., 1989</td>
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<td>U FD</td>
<td>12 w</td>
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<td>NR</td>
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<td>U FD</td>
<td>32 d</td>
<td>3</td>
<td>w</td>
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<td>Mouse (Mus musculus)</td>
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<td>U FD</td>
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<td>50</td>
<td>d</td>
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<td>NR</td>
<td>NR</td>
<td>JV</td>
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<td>24</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>103 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
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<tr>
<td>25</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>35 d</td>
<td>NR</td>
<td>NR</td>
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<td>26</td>
<td>Mooney and Cromwell, 1997</td>
<td>Pig (Sus scrofa)</td>
<td>M FD</td>
<td>90 d</td>
<td>100 d</td>
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<td>Mooney and Cromwell, 1997</td>
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<td>Zahid et al., 1990</td>
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<td>Elbetieha and Al-Hamood, 1997</td>
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<td>31</td>
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<td>Mouse (Mus musculus)</td>
<td>U FD</td>
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<td>NR</td>
<td>NR</td>
<td>JV</td>
</tr>
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</table>

**Legend:**
- **AD** = adult
- **AGGT** = aggression
- **B** = both
- **BEH** = behavior
- **BDWT** = body weight changes
- **BEH** = behavior
- **BL** = blood
- **BLPR** = blood pressure
- **CHM** = chemical changes
- **d** = days
- **DR** = drinking
- **F** = female
- **FCNS** = food consumption
- **FD** = food
- **FDB** = feeding behavior
- **FDCV** = food conversion efficiency
- **GRO** = growth
- **GLUC** = glucose
- **GPHY** = general physiology
- **GSLN** = gross lesions
- **GV** = gavage
- **GTS** = gross body weight changes
- **GTS** = gross body weight changes
- **H** = hematocrit
- **HIS** = histology
- **IE** = interrenal
d
- **K** = kidney
- **L** = liver
- **M** = measured
- **m** = months
- **MOR** = effects on survival
- **MORT** = mortality
- **NCRO** = necrosis
- **NR** = not reported
- **ORWT** = organ weight changes
- **OY** = ovary
- **PHY** = physiology
- **PL** = plasma
- **PROG** = progeny counts or numbers
- **PRTL** = total protein
- **REP** = reproduction
- **SM** = sexually mature
- **SPCL** = sperm cell counts
- **SR** = serum
- **TE** = testes
- **TEWT** = testes weight
- **TH** = teeth
- **U** = unmeasured
- **w** = weeks
- **WO** = whole organism

**Data Evaluation Score:**
- 66
- 67
- 68
- 74
- 71
- 70
- 69
- 72
- 73
- 74
- 75
- 76
- 77
- 78
- 79
- 80
- 81
- 82
- 83
- 84
- 85
- 86
- 87
- 88
- 89
- 90
- 91
- 92
- 93
- 94
- 95
- 96
- 97
- 98
- 99
- 100

**Eco-SSL for Chromium**

April 2008
Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.40 mg/kg bw/d. There are no bounded LOAEL values for comparison.

5) The mammalian wildlife TRV for trivalent chromium is equal to 2.40 mg chromium/kg bw/day which is the geometric mean NOAEL for effects on growth and reproduction.
<table>
<thead>
<tr>
<th>Result #</th>
<th>Reference</th>
<th>Test Organism</th>
<th>Sex</th>
<th>Lifestage</th>
<th>Method of Analyses</th>
<th>NOAEL Dose (mg/kg bw/day)</th>
<th>LOAEL Dose (mg/kg bw/day)</th>
<th>Data Evaluation Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rao et al., 1983</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>2 M</td>
<td>FD 1 yr</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>2</td>
<td>Rao et al., 1981</td>
<td>Rat (Rattus norvegicus)</td>
<td>Male</td>
<td>2 M</td>
<td>FD 1 yr</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>R.O.W. Sciences, Inc.</td>
<td>Rat (Rattus norvegicus)</td>
<td>Male</td>
<td>5 UX</td>
<td>FD 9 w</td>
<td>9 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>4</td>
<td>R.O.W. Sciences, Inc.</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>5 UX</td>
<td>FD 3 w</td>
<td>9 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>5</td>
<td>Vyskocil et al., 1993</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>2 DR</td>
<td>6 mo</td>
<td>8 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>R.O.W. Sciences Inc, 1997</td>
<td>Mouse (Mus musculus)</td>
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<td>4 UX</td>
<td>FD 14 w</td>
<td>10 w</td>
<td>GE</td>
<td>F</td>
</tr>
<tr>
<td>7</td>
<td>Meenakshi et al., 1989</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>2 GV</td>
<td>60 d</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>8</td>
<td>Chowdhury and Mitra, 1995</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>4 GV</td>
<td>90 d</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>9</td>
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<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>5 UX</td>
<td>FD 9 w</td>
<td>9 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>10</td>
<td>R.O.W. Sciences, Inc.</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>5 UX</td>
<td>FD 9 w</td>
<td>9 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>11</td>
<td>R.O.W. Sciences Inc, 1997</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>4 UX</td>
<td>FD 14 w</td>
<td>10 w</td>
<td>GE</td>
<td>F</td>
</tr>
<tr>
<td>12</td>
<td>Al-Hamood et al., 1998</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>2 DR</td>
<td>29 d</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>13</td>
<td>Gribble, 1974</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>2 DR</td>
<td>3 d</td>
<td>7 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>14</td>
<td>Gates et al., 1947</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>4 DR</td>
<td>3 d</td>
<td>5 d</td>
<td>NR</td>
<td>JR</td>
</tr>
<tr>
<td>15</td>
<td>Bataineh et al., 1997</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>2 DR</td>
<td>12 w</td>
<td>NR</td>
<td>AD</td>
<td>M</td>
</tr>
<tr>
<td>16</td>
<td>Trivedi et al., 1989</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>4 DR</td>
<td>19 d</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>17</td>
<td>Diaz-Mayans et al., 1986</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>3 DR</td>
<td>28 d</td>
<td>NR</td>
<td>JR</td>
<td>SM</td>
</tr>
<tr>
<td>18</td>
<td>Rao et al., 1983</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>2 M</td>
<td>FD 1 yr</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>19</td>
<td>Rao et al., 1991</td>
<td>Rat (Rattus norvegicus)</td>
<td>Male</td>
<td>2 M</td>
<td>FD 1 yr</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>20</td>
<td>Vyskocil et al., 1993</td>
<td>Rat (Rattus norvegicus)</td>
<td>Male</td>
<td>2 DR</td>
<td>6 mo</td>
<td>8 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>21</td>
<td>R.O.W.Sciences Inc, 1997</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>4 UX</td>
<td>FD 14 w</td>
<td>10 w</td>
<td>GE</td>
<td>F</td>
</tr>
<tr>
<td>22</td>
<td>R.O.W. Sciences, Inc.</td>
<td>Mouse (Mus musculus)</td>
<td>Male</td>
<td>5 UX</td>
<td>FD 9 w</td>
<td>9 w</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>23</td>
<td>Meenakshi et al., 1989</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>2 GV</td>
<td>60 d</td>
<td>NR</td>
<td>JR</td>
<td>V</td>
</tr>
<tr>
<td>24</td>
<td>Bataineh et al., 1997</td>
<td>Rattus norvegicus</td>
<td>Male</td>
<td>2 DR</td>
<td>12 w</td>
<td>NR</td>
<td>JR</td>
<td>AD</td>
</tr>
</tbody>
</table>

**Hexavalent Chromium**

- **Behavior**
- **Physiology**
- **Pathology**
- **Reproduction**
- **Growth**
Table 6.2 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)  
Hexavalent Chromium

<table>
<thead>
<tr>
<th>Result #</th>
<th>Reference</th>
<th>Ref No.</th>
<th>Test Organism</th>
<th>Method of Analyses</th>
<th>Route of Exposure</th>
<th>Excretion Units</th>
<th>Exposure Duration</th>
<th>Duration Units</th>
<th>Age Units</th>
<th>Age</th>
<th>Effect Type</th>
<th>Effect Measure</th>
<th>Response Site</th>
<th>NOAEL Dose (mg/kg body wt)</th>
<th>LOAEL Dose (mg/kg body wt)</th>
<th>Data Evaluation Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>Kanojia et al., 1996</td>
<td>3049</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>U</td>
<td>DR</td>
<td>39 d</td>
<td>120 d</td>
<td>GE</td>
<td>F</td>
<td>GRO</td>
<td>BDWT</td>
<td>WO</td>
<td>26.8</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Elbetieha and Al-Hamood, 1997</td>
<td>3023</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>U</td>
<td>DR</td>
<td>12 w</td>
<td>50 d</td>
<td>JV</td>
<td>M</td>
<td>GRO</td>
<td>BDWT</td>
<td>WO</td>
<td>98.7</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Survival

<table>
<thead>
<tr>
<th>Result #</th>
<th>Reference</th>
<th>Ref No.</th>
<th>Test Organism</th>
<th>Method of Analyses</th>
<th>Route of Exposure</th>
<th>Excretion Units</th>
<th>Exposure Duration</th>
<th>Duration Units</th>
<th>Age Units</th>
<th>Age</th>
<th>Effect Type</th>
<th>Effect Measure</th>
<th>Response Site</th>
<th>NOAEL Dose (mg/kg body wt)</th>
<th>LOAEL Dose (mg/kg body wt)</th>
<th>Data Evaluation Score</th>
</tr>
</thead>
<tbody>
<tr>
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<td>R.O.W. Sciences, Inc.</td>
<td>25925</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>5</td>
<td>UX</td>
<td>FD</td>
<td>9 w</td>
<td>9 w</td>
<td>JV</td>
<td>M</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>8.48</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Meenakshi et al., 1989</td>
<td>3061</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>2</td>
<td>U</td>
<td>GV</td>
<td>60 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>10.0</td>
<td>85</td>
</tr>
<tr>
<td>62</td>
<td>R.O.W. Sciences Inc, 1997</td>
<td>25926</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>4</td>
<td>UX</td>
<td>FD</td>
<td>14 w</td>
<td>10 w</td>
<td>GE</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>30.3</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>R.O.W. Sciences, Inc.</td>
<td>25927</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>5</td>
<td>UX</td>
<td>FD</td>
<td>9 w</td>
<td>9 w</td>
<td>JV</td>
<td>M</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>32.5</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Gates et al. 1947</td>
<td>3029</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>25 d</td>
<td>NR</td>
<td>NR</td>
<td>JV</td>
<td>B</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>25.0</td>
<td>77</td>
</tr>
<tr>
<td>65</td>
<td>Diaz-Mayans et al., 1986</td>
<td>3023</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>3</td>
<td>U</td>
<td>DR</td>
<td>28 d</td>
<td>NR</td>
<td>NR</td>
<td>SM</td>
<td>M</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>25.4</td>
<td>74</td>
</tr>
<tr>
<td>66</td>
<td>Kanojia et al., 1998</td>
<td>3050</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>3 mo</td>
<td>50 d</td>
<td>JV</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>33.2</td>
<td>86.6</td>
<td>79</td>
</tr>
<tr>
<td>67</td>
<td>Kanojia et al., 1996</td>
<td>3049</td>
<td>Rat (<em>Rattus norvegicus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>39 d</td>
<td>120 d</td>
<td>GE</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>63.7</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>Junaid et al., 1996</td>
<td>3046</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>20 d</td>
<td>4 mo</td>
<td>SM</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>82.1</td>
<td>121</td>
<td>79</td>
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<td>69</td>
<td>Junaid et al., 1996</td>
<td>3047</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>8 d</td>
<td>NR</td>
<td>NR</td>
<td>GE</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>131</td>
<td>74</td>
</tr>
<tr>
<td>70</td>
<td>Trivedi et al., 1989</td>
<td>31</td>
<td>Mouse (<em>Mus musculus</em>)</td>
<td>4</td>
<td>U</td>
<td>DR</td>
<td>19 d</td>
<td>NR</td>
<td>NR</td>
<td>GE</td>
<td>F</td>
<td>MOR</td>
<td>MORT</td>
<td>WO</td>
<td>163</td>
<td>74</td>
</tr>
</tbody>
</table>

AD = adult; AGGT = aggression; ALBM = albumins; B = both; BEH = behavior; BDWT = body weight changes; BEH = behavior; BL = blood; CHM = chemical changes; d = days; DR = drinking water; EXCR = excretion; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; GE = gestational; GHS = general histology; GLUC = glucose; GREP = general reproduction; GRO = growth; GRS = gross body weight changes; GV = gavage; HIS = histology; HMGL = hemoglobin; HRM = hormone changes; JV = juvenile; KI = kidney; LC = lactation; LI = liver; M = male; M = measured; MCPV = mean corpuscular volume; mo = months; MOR = mortality; MORT = mortality; MT = multiple; NCRO = necrosis; NR = not reported; ORW = organ weight changes ORWT = organ weight changes (absolute); OV = ovipost; PHY = physiology; PROG = progeny counts or numbers; PRWT = progeny weight; REP = reproduction; RSEM = resorbed embryos; SM = sexually mature; SM = sperm; SMIX = weight relative to body weight; SPCL = sperm cell counts; SR = serum; TE = testes; TEDG = testes degeneration; TEWT = testes weight; TSTR = testosterone; U = unmeasured; UR = urine; UX = measured but concentrations not reported; w = weeks; WCON = water consumption; WO = whole organism; yr = years.
Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.
2) There are three NOAEL results available for calculation of a geometric mean.
4) The geometric mean is equal to 9.24 mg/kg bw/d. The geometric mean is lower than the lowest bounded LOAEL for growth, reproduction or mortality.
5) The mammalian wildlife TRV for hexavalent chromium is equal to 9.24 mg chromium/kg bw/day which is equal to the geometric mean of NOAEL values for reproduction and growth.
6.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values are calculated for mammalian wildlife, one each for three receptor groups representing different trophic levels. The mammalian Eco-SSLs derived for chromium are calculated according to the Eco-SSL guidance (U.S. EPA 2003) and are summarized in Table 6.3 for trivalent chromium and 6.4 for hexavalent chromium.

<table>
<thead>
<tr>
<th>Surrogate Receptor Group</th>
<th>TRV for Trivalent Chromium (mg dw/kg bw/d)(^1)</th>
<th>Food Ingestion Rate (FIR)(^2) (kg dw/kg bw/d)</th>
<th>Soil Ingestion as Proportion of Diet (P(_s))(^2)</th>
<th>Concentration of Chromium in Biota Type (i)(^2,3) (B(_i)) (mg/kg dw)</th>
<th>Eco-SSL (mg/kg dw)(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammalian herbivore (vole)</td>
<td>2.40</td>
<td>0.0875</td>
<td>0.032</td>
<td>B(_i) = 0.041 * Soil(_i) where i = plants</td>
<td>380</td>
</tr>
<tr>
<td>Mammalian ground insectivore (shrew)</td>
<td>2.40</td>
<td>0.209</td>
<td>0.030</td>
<td>B(_i) = 0.306 * Soil(_i) where i = earthworms</td>
<td>34</td>
</tr>
<tr>
<td>Mammalian carnivore (weasel)</td>
<td>2.40</td>
<td>0.130</td>
<td>0.043</td>
<td>(\ln(B_i) = 0.7338 * \ln(Soil_i) - 1.4599) where i = mammals</td>
<td>180</td>
</tr>
</tbody>
</table>

1 The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
2 Parameters (FIR, P\(_s\), B\(_i\) values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
3 B\(_i\) = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
4 HQ = FIR * (Soil\(_i\) * P\(_s\) + B\(_i\)) / TRV solved for HQ=1 where Soil\(_i\) = Eco-SSL (Equation 4-2; U.S. EPA, 2003).
NA = Not Applicable

<table>
<thead>
<tr>
<th>Surrogate Receptor Group</th>
<th>TRV for Hexavalent Chromium (mg dw/kg bw/d)(^1)</th>
<th>Food Ingestion Rate (FIR)(^2) (kg dw/kg bw/d)</th>
<th>Soil Ingestion as Proportion of Diet (P(_s))(^2)</th>
<th>Concentration of Chromium in Biota Type (i)(^2,3) (B(_i)) (mg/kg dw)</th>
<th>Eco-SSL (mg/kg dw)(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammalian herbivore (vole)</td>
<td>9.24</td>
<td>0.0875</td>
<td>0.032</td>
<td>B(_i) = 0.041 * Soil(_i) where i = plants</td>
<td>1400</td>
</tr>
<tr>
<td>Mammalian ground insectivore (shrew)</td>
<td>9.24</td>
<td>0.209</td>
<td>0.030</td>
<td>B(_i) = 0.306 * Soil(_i) where i = earthworms</td>
<td>130</td>
</tr>
<tr>
<td>Mammalian carnivore (weasel)</td>
<td>9.24</td>
<td>0.130</td>
<td>0.043</td>
<td>(\ln(B_i) = 0.7338 * \ln(Soil_i) - 1.4599) where i = mammals</td>
<td>870</td>
</tr>
</tbody>
</table>

1 The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
2 Parameters (FIR, P\(_s\), B\(_i\) values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
3 B\(_i\) = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
4 HQ = FIR * (Soil\(_i\) * P\(_s\) + B\(_i\)) / TRV solved for HQ=1 where Soil\(_i\) = Eco-SSL (Equation 4-2; U.S. EPA, 2003).
NA = Not Applicable
7.0 REFERENCES

7.1 General Chromium References


7.2 References Used in Deriving Plant and Soil Invertebrate Eco-SSLs


7.3 References Rejected for Use in Deriving Plant and Soil Invertebrate Eco-SSLs

These references were reviewed and rejected for use in derivation of the Eco-SSL. The definition of the codes describing the basis for rejection is provided at the end of the reference sections.


Mix

No Dose

No Control

FL

Media

No Control

Media

Media

No Dur

No Dur

Media

No Control

OM, pH

Media

OM, pH

**Media**

**No Dur**

**FL**

**FL**

**Media**

**OM**

**OM**

**OM**

**Rev**

**No Dur**

**No Dose**

**FL**

**Rev**

**No Dose**

**No Toxicity**


No Dose

Media
amended with sewage sludge and heavy metals, using the common soil ciliate Colpoda steinii.  

Media
and Early Growth of Terrestrial Plants.  In: W. Wang, J.W.Gorsuch., and W.R.Lower (Eds.),  
Plants for Toxicity Assessment, ASTM STP 1091, Philadelphia, PA , 49-58

Mix
Gray, N. F.  1988.  Ecology of nematophagous fungi: effect of the soil nutrients nitrogen, 

FL
Grigor'eva, T. I., Pertsovskaya, A. F., Tonkopii, N. I., Perelygin, V. M., Beibetkhan, D., Velikanov, 

Mix
Grubinger, Vernon P., Gutenmann, Walter H., Doss, G. James, Rutzke, Michael, and List, Donald J. 

Media

Mix
Gunse, B., Poschenrieder, C., and Barcelo, J.  1990.  Correlation between extractable chromium, 
chromium uptake and productivity of beans (Phaseolus vulgaris) grown on tannery sludge-amended 

FL
Sludges (II Cromo e L'Impiego in Agricoltura di Fanghi in Conceria).  Cuoio Pelli Mater.Concianti 
68(1), 57-65 (SPA) (ENG ABS)

FL
Gusenleitner, J. and Nimmervoll, W.  1988.  The Effect of Chromium Accumulation on Crop 

FL
Gusenleitner, J. and Nimmervoll, W.  1988.  The Effect of Chromium Accumulation on Growth of 
Cultivated Plants in a Potted Trial with Two Different Soils of Upper Austria.  Bodenkultur.  39(3): 
217-231.

Species
Hadwiger, L., Bromersen, S., and Eddy, R.  1973.  Increased Template Activity in Chromatin from 

Dup
1120-1128.

No COC

No ERE

FL
Hankawa, Y.  1971.  Residues of organochlorine in crops and soil by electron-capture gas

**Media**


No Data


Media


Media


Media


Media


Media


Meth


Media


Media


Media


Media


Media


Media

Ma, T. H. 1981. Tradescantia-paludosa Micronucleus Bioassay and Pollen Tube Chromatid Aberration Test for In Situ Monitoring and Mutagen Screening. Environ.Health Perspect. 37, 85-90

OM, pH


No Dose


OM, pH

Mikula, W. and Indeka, L. 1997. Heavy metals in allotment gardens close to an oil refinery in plock. Water Air Soil Pollut. 96(1/4), 61-71

Score


OM


---

Eco-SSL for Chromium 25 April 2008
No Dose


Media


FL


FL


Mix


Media


Media


Rev


No ERE


Species


Media


FL


FL


Score


Media


Mix

Rout, G. R., Samantaray, S., and Das, P. 2000. Effects of Chromium and Nickel on Germination and
Growth in Tolerant and Non-Tolerant Populations of Echinochloa colona (L.) Link. Chemosphere 40(8), 855-859

No Data

Rev

pH

No Dur

No Dur

OM, pH

OM, pH

Mix

Media

Mix

Mix

In Vit

OM, pH

Media

Rev

Species
Rev


Media


OM, pH


Media


Mix


No COC


Media


No ERE


No ERE


Media


Media


No Control


Media


Species


Media


FL  Uccelli, Raffaella, Angelone, Massimo, Cima, Maria Grazia, Ferrandi, Luigi, Pompei, Franco, Stronati, Laura, and Triolo, Lucio. 1992. Air pollution on the territory of the Tarquinia Agricultural University. Concentrations of nickel, chromium, lead, and cadmium in soil and in some plant and animal species. Inquinamento 34(10), 64-74


Wang, Y. P. and Chao, C. C. 1992. Effects of vesicular-arbuscular mycorrhizae and heavy metals on the growth of soybean and phosphate and heavy metal uptake by soybe. AGRIC ASSOC CHINA NEW SER (157), 6-20


7.4 References Used in Deriving Wildlife TRVs


7.5 References Rejected for Use in Derivation of Wildlife TRV

These references were reviewed and rejected for use in derivation of the Eco-SSL. The definition of the codes describing the basis for rejection is provided at the end of the reference sections.

Unrel Addition of calcium ions for enhancing the safety of metal-ligand chelates as magnetic resonance imaging agents and x-ray contrast agents.  *PCT Int. Appl.*  10 pp.


HHE Autoradiographic and immunofluorescent detection of low concentrations of actinomycin d bound to human metaphase chromosomes.  791581  ORDER NO: AAD82-23004

Diss Content and evolution of cadmium, cobalt, chromium, copper, nickel, lead, and zinc in soils of l'horta and ribera baixa regions (valencia) (spain) original title: contenido y evolucion de cadmio, cobalto, cromo, cobre, niquel, plomo, cinc en suelos de las comarcas de l'horta y la baixa (valencia).  01269400  ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.

Unrel 1996.  *Environmental Cleanup: Progress in Resolving Long-Standing Issues at the Rocky Mountain Arsenal*

Diss Epigenetic mechanisms of chromium action (glutathione).

Diss Immune response to orthopaedic biomaterials.  01440048  ORDER NO: AADAA-I9534554


Surv 1958.  *Regional Monitoring Activities, May 1958. HW-56226*

Diss A study of the chemistry and mutagenicity of welding fume.  910380  ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.

FL 1980.  [A study on the combined toxicity of DDT, 666, As, Hg and Cr (author's transl)].  *Chung-Hua Yu Fang i Hsueh Tsa Chih*  14(2):  86-8.

Diss Theoretical studies of the electronic structure and bonding in some transition metal complexes of vanadium, chromium, iron, nickel and palladium.  765403  ORDER NO: AAD81-24610


**Unrel**


**No Oral**


**Anat**


**CP**


**Fate**


**FL**


**No Control**


**Herp**


**CP**

Alcedo, J. and Wetterham, k. 1990. effect of chromium-vi on metallothionein gene expression. *81ST Annual Meeting of the American Association for Cancer Research*

**No Oral**

Alcedo, Joy A., Misra, Manoj, Hamilton, Joshua W., and Wetterhahn, Karen E. 1994. the genotoxic carcinogen chromium(vi) alters the metal-inducible expression but not the basal

**CP**

**Unrel**

**Diss**
Amann, R. P. reproductive toxicology of chemical mixtures. *Crisp Data Base National Institutes Of Health*

**Nut def**

**Org met**

**Surv**
Andreu Perez, Vicente. 1991. content and evolution of cadmium, cobalt, chromium, copper, nickel, lead, and zinc in soils of l'horta and ribera baixa regions (valencia) (spain): <original>contenido y evolucion de cadmio, cobalto, cromo, cobre, niquel, plomo, cinc en suelos de las comarcas de l'horta y la ribera baixa (valencia).

**Drug**

**Meth**

**No Oral**

**Unrel**
Anon. 1990. regional monitoring activities, may 1958. *Govt Reports Announcements & Index (GRA&I)*

**Bio Acc**

**Herp**

**Bio Acc**

**No Oral**

**Acu**
Appenroth, D., Gambaryan, S., Friese, K. H., and Braeunlich, H. 1990. influence of metyrapone


ATSDR. 1993.


Bencko, V., Arbetova, D., and Skupenova, V. 1981. use of domesticated rabbit tissues for monitoring of environmental pollution by toxic metals (mn, pb, cr, cd, ni).  Journal of Hygiene, Epidemiology, Microbiology, and Immunology 25(2)

Bendell-Young, L. I(a) and Bendell, J. F. 1999. grit ingestion as a source of metal exposure in the spruce grouse, dendragapus canadensis.  Environmental Pollution. 106(3): 405-412.


Bierei, G. R.  1974. Population Response and Heavy Metal Concentrations in Cottontail Rabbits and Small Mammals in Wastewater Irrigated Habitat


Bogolepov, N. N. and Verbitskaya, L. B.  electron microscopic study of the rat cerebral cortex impregnated by the golgi method.  ARKH ANAT GISTOL EMBRIOL. Arkhiv Anatomiiv Gistologii i Embriologii.  73 (8). 1977 81-84.


Burger, J., Marquez, M., and Gochfeld, M. 1994. Heavy metals in the hair of opossum from palo

**Bio Acc**  

**Bio Acc**  

**Bio Acc**  

**Herp**  

**IMM**  

**IMM**  

**IMM**  

**Species**  

**In Vit**  

**In Vit**  

**In Vit**  

**Bio Acc**  
Herp  Calevro, F., Campani, S., Ragghianti, M., Bucci, S., and Mancino, G.  1998.  tests of toxicity and teratogenicity in biphasic vertebrates treated with heavy metals (cr3+, al3+, cd2+).  


Mix  Chapin, Robert E., Phelps, Jerry L., Schwetz, Bernard A., and Yang, Raymond S. H.  toxicology

**CP**


**CP**


**Fate**


**Species**


**HHE**


**No Org**


**Unrel**


**Org met**


**FL**


**FL**


**Drug**


**Soil**


**FL**


**No Dur**


**FL**


---

*Eco-SSL for Chromium* 43 April 2008


**FL** Cobo, J. M., Gonzalez, M. J., Perez Piqueras, J. L., Aguilar, M. V., and Martinez Para, M. C. Alcala de Henares Univ. Madrid Spain Facultad de Farmacia.  1990. effect of chromium over insulin levels and its interaction with the arsenic of the diet.  *original* efecto del cromo sobre los niveles de insulina: interaccion con el arsenico de la dieta.  *Anales De Bromatologia. V. 42(1) P. 133-138*


Mix  Constans, A. A., Yang, R. S., Baker, D. C., and Benjamin, S. A.  1995.  a unique pattern of hepatocyte proliferation in f344 rats following long-term exposures to low levels of a chemical mixture of groundwater contaminants.  Carcinogenesis  16(2): 303-10.


**Species**


**FL**


**CP**


**FL**


**CP**


**Mineral**


**CP**


**FL**


**Abstract**


**Unrel**


**FL**


**Bio Acc**


**Org met**


**Unrel**


FL  Ellen, G., Loon, J. W. van, and Tolsma, K.  1989. copper, chromium, manganese, nickel and zinc

**Meth**

**Unrel**

**Unrel**

**No Oral**

**In Vit**

**FL**

**FL**

**Surv**

**No Dose**

**In Vit**

**Org met**

**Bio Acc**

**Mix**

**Unrel**

**Rev**


Nut

Drug

Unrel

Bio Acc

Bio Acc

Surv

Bio Acc
Gochfeld, M. UMDNJ-Robert Wood Johnson Medical School Piscataway NJ. spatial patterns in a bioindicator: heavy metal and selenium.  Arch Environ Contam Toxicol. V33, N1, P63(8)

Aquatic

Herp

Unrel

FL

CP

Fate

No Org

No Oral

IMM


Diss Hasten, D. L. 1994. *Effects of Chromium Picolinate on Growth and Body Composition in the Rat*


Horstmann, Uwe E. and Haelbich, Ingo W. chemical composition of banded iron-formations of the griqualand west sequence, northern cape province, south africa, in comparison with other


Hui, Clifford A. University of California Davis and Beyer, W. Nelson USGS Laurel MD. sediment ingestion of two sympatric shorebird species. *Sci Total Environ.* V224, N1-3, P227(7)


Abstract

Nut def

Prim
Hutcheson, D. P. 1975. safety of heavy metals as nutritional markers. 74-80.

Mix

Bio Acc

FL

Surv

HHE

Abstract

No Oral

No Oral

CP

No Oral

Acu

Herp

In Vit
Kaalaas, John Atle, Ringsby, Thor Harald, and Lierhagen, Syverin. metals and selenium in wild
Volume Date 1995, 36(3): 251-70.

2097.

and later events in the grenville province, eastern labrador. Precambrian Res. (1996) 80(3-4):
239-260.


Kanti, A. and Smith, M. A. 1997. effects of heavy metals on chondrogenic differentiation of
embryonic chick limb Cells. In Vitro Toxicology. 10(3): 329-338.

Kaplan, R., Polasek, L., Skarka, P., Strakova, J., Dvorak, M., and Benes, B. 1987. verifying the
effectiveness of trivalent chromium in the fattening of chickens. Biol. Chem. Zivocisne Vyroby-

Karimov, T. K., Kim, B. I., Kolesova, O. A., Bizhanov, Z. H. A., Khasenova, K. Kh., and
Berdongarova, A. K. 1988. effect of retinol tocopherol ascorbic acid and special diet on vitamin

Kato, Takayasu, Sone, Iseki, Hattori, Akio, and Yoshikawa, Hiroshi. protective effect of iron

Keefer, Robert F., Singh, Rabindar N., Bennett, Orus L., and Horvath, Donald J. 1983. chemical

supplementation on performance, immune response and disease resistance of steers. Journal of

Keith, R. L., Gandolfi, A. J., McIntyre, L. C. Jr., Ashbaugh, M. D., and Fernando, Q. analysis of
heavy metal deposition in renal tissue by sectional mapping using pixe. Nucl. Instrum. Methods

Kelley, Timothy R., Pancorbo, Oscar C., Merka, William C., Thompson, Sidney A., Cabrera,
Miguel L., and Barnhart, Harold M. 1998. accumulation of elements in fractionated broiler litter

Kennedy, B. W. and Beal, T. S. 1991. minerals leached into drinking water from rubber stoppers.


chromium requirements of young bovine animals.  Sel'SkokhozYaistvennaya Biologiya(2): 78-84.

**Bio Acc**

**Nut def**

**Mix**

**FL**

**No Oral**

**Unrel**

**No Oral**

**FL**

**FL**

**No Data**

**No Data**

**No Oral**

**In Vit**

**FL**

**Surv**
LaDelfe, C. M.  1981.Detailed Geochemical Survey Data Release for the San Andres-Oscura Mountains Special Study Area, New Mexico.  GJBX-215-81; LA-8016-MS.


Rev  Lindemann, M. D.  1996.  supplemental chromium may provide benefits, but costs must be weighed.  Feedstuffs.  68(53): 14-17.


Malins, D. C. 1979.*Environmental Assessment of the Alaskan Continental Shelf. Volume 5. Biological Studies: Assessment of Available Literature on Effects of Oil Pollution on Biota in Arctic and Subarctic Waters.* <NOTE> Final Rept. 1 Jul 75-30 Sep 76


Diss  Matheson, J. M.  1997. *Immune Mechanisms in Metal-Induced Nephrotoxicity (Cadmium, Chromium, Kidney, Autoimmune)*


FL  Morozova, V. V. and Veklenko, V. P.  1967. the neuro histological and some histochemical changes in the wall of the aorta in chromium poisoning.  Uch Zap Anat Gistol Embriol Respub Srednei Azii Kaz.  3(1): 77-78.


Eco-SSL for Chromium

Eco-SSL for Chromium

April 2008
Eco-SSL for Chromium


Unrel Pankakoski Erkki(A), Hyvarinen Heikki, Jalkanen Marita(A), and Koivisto Ilkka. 1993. accumulation of heavy metals in the mole in finland. *Environmental Pollution* 80(1): 9-16.


Surv Peles, J. D. Savannah River Ecology Laboratory Aiken SC and Barrett, G. W. University of Georgia Athens. assessment of metal uptake and genetic damage in small mammals. *Bull Environ Contam Toxicol.* V59, N2, P279(6)


Org met Piao, X. S., Han, I. K., Kim, J. H., Bae, S. H., Kim, Y. H., and Liang, C. 1997. effects of metabolic active substances addition to diets with different protein level on the amount of...

**No Dose**

**Fate**

**Fate**

**No COC**

**Plant**

**FL**

**Phys**

**Phys**

**Mix**

**No Oral**

**No Oral**

**No Oral**

**No Dose**

**Unrel**

**No Oral**

**Surv**
Reichertova, E., Takac, E., Kranerova, J., Vencko, B., Sulicova, L., and Holusa, R. biomonitoring


**FL**

**FL**

**Phys**

**Surv**

**In Vit**

**No Oral**

**Org met**

**Rev**

**Rev**

**Alt**

**Unrel**

**FL**

**Nutrition**
No Dose

Fate

Unrel

Unrel

FL

No Control

Rev

Dup

Nut def

Surv

Mix

No COC

Dup

Dup

Nutrition
Schwarz, K. Recent dietary trace element research exemplified by tin, fluorine and silicon. *Federation Proceedings.* 33 (6), 1974, 1748-1757

Mineral
Seaborn, Carol D., Mitchell, Earl D., and Stoecker, Barbara J. 1993. Vanadium and ascorbate effects on 3-hydroxy-3-methylglutaryl coenzyme a reductase, cholesterol and tissue minerals in...


Unrel  Snyder, C. A. core--exposure and analytical facility. Crisp Data Base National Institutes Of Health


Vreeburg, K. J., de Groot, K., van Hoogstraten, I. M., von Blomberg, B. M., and Scheper, R. J.  1991.  successful induction of allergic contact dermatitis to mercury and chromium in mice.  *International Archives of Allergy and Applied Immunology*  96(2)


Ward, T. L.  1995.*Dietary Chromium Supplementation for Pigs and Chickens (Trace Minerals)*


Wasser, J. S.  1985.*Hibernation in the Northern Water Snake, Nerodia Sipedon: Seasonal Variations in Plasma and Tissue Chemistry (Plasma Spectrometry, Ectotherm)*


Whanger, P. D. and Weswig, P. H.  1975.  effects of selenium chromium and anti oxidants on
growth eye cataracts plasma cholesterol and blood glucose in selenium deficient vitamin e supplemented Rats.  


**Surv**


**ENVIRON MONIT ASSESS.** 6(1): p91-111.

**Surv**


**Abstract**


**No Oral**


**Rev**

Williams, S. N. and McDowell, L. R. 1985. newly discovered and toxic elements.  


**Unrel**


**Unrel**

Wilson, M. J. and Berrow, M. L. 1978.  the mineralogy and heavy metal content of some serpentinite soils in north-east scotland.  

**Chemie Der Erde.** 37: 181-205.

**Sed**


**Surv**


**Archives of Environmental Contamination and Toxicology** 38(1): 128-136.

**Unrel**


**Aquaculture.** 25(2/3): 269-274.

**Surv**


**Unrel**


**Nut def**

Woolliscroft, J. and Barbosa, J. 1977. analysis of chromium induced carbohydrate intolerance in the rat.  

**J. Nutr.** 107(9): 1702-6.

**Anat**


t.(64):  24-8.

**Gene**

**Unrel**

**No Oral**

**Fate**

**Unrel**
<table>
<thead>
<tr>
<th>Rejection Criteria</th>
<th>Description</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT (Abstract)</td>
<td>Abstracts of journal publications or conference presentations.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>ACUTE STUDIES (Acu)</td>
<td>Single oral dose or exposure duration of three days or less.</td>
<td>Wildlife</td>
</tr>
<tr>
<td>AIR POLLUTION (Air P)</td>
<td>Studies describing the results for air pollution studies.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>ALTERED RECEPTOR (Alt)</td>
<td>Studies that describe the effects of the contaminant on surgically-altered or chemically-modified receptors (e.g., right nephrectomy, left renal artery ligature, hormone implant, etc.).</td>
<td>Wildlife</td>
</tr>
<tr>
<td>AQUATIC STUDIES (Aquatic)</td>
<td>Studies that investigate toxicity in aquatic organisms</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>ANATOMICAL STUDIES (Anat)</td>
<td>Studies of anatomy. Instance where the contaminant is used in physical studies (e.g., silver nitrate staining for histology).</td>
<td>Wildlife</td>
</tr>
<tr>
<td>BACTERIA (Bact)</td>
<td>Studies on bacteria or susceptibility to bacterial infection.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>BIOACCUMULATION SURVEY (Bio Acc)</td>
<td>Studies reporting the measurement of the concentration of the contaminant in tissues.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>BIOLOGICAL PRODUCT (BioP)</td>
<td>Studies of biological toxicants, including venoms, fungal toxins, <em>Bacillus thuringiensis</em>, other plant, animal, or microbial extracts or toxins.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>BIOMARKER ( Biom)</td>
<td>Studies reporting results for a biomarker having no reported association with an adverse effect and an exposure dose (or concentration).</td>
<td>Wildlife</td>
</tr>
<tr>
<td>CARCINOGENICITY STUDIES (Carcin)</td>
<td>Studies that report data only for carcinogenic endpoints such as tumor induction. Papers that report systemic toxicity data are retained for coding of appropriate endpoints.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>CHEMICAL METHODS (Chem Meth)</td>
<td>Studies reporting methods for determination of contaminants, purification of chemicals, etc. Studies describing the preparation and analysis of the contaminant in the tissues of the receptor.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>CONFERENCE PROCEEDINGS (CP)</td>
<td>Studies reported in conference and symposium proceedings.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>DEAD (Dead)</td>
<td>Studies reporting results for dead organisms. Studies reporting field mortalities with necropsy data where it is not possible to establish the dose to the organism.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>DISSERTATIONS (Diss)</td>
<td>Dissertations are excluded. However, dissertations are flagged for possible future use.</td>
<td>Wildlife</td>
</tr>
<tr>
<td>DRUG (Drug)</td>
<td>Studies reporting results for testing of drug and therapeutic effects and side-effects. Therapeutic drugs include vitamins and minerals. Studies of some minerals may be included if there is potential for adverse effects.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>DUPLICATE DATA (Dup)</td>
<td>Studies reporting results that are duplicated in a separate publication. The publication with the earlier year is used.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>Rejection Criteria</td>
<td>Description</td>
<td>Receptor</td>
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<tr>
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<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>ECOLOGICAL INTERACTIONS</strong> (Ecol)</td>
<td>Studies of ecological processes that do not investigate effects of contaminant exposure (e.g., studies of “silver” fox natural history; studies on ferrets identified in iron search).</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>EFFLUENT</strong> (Effl)</td>
<td>Studies reporting effects of effluent, sewage, or polluted runoff.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>ECOLOGICALLY RELEVANT ENDPOINT</strong> (ERE)</td>
<td>Studies reporting a result for endpoints considered as ecologically relevant but is not used for deriving Eco-SSLs (e.g., behavior, mortality).</td>
<td>Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>CONTAMINANT FATE/METABOLISM</strong> (Fate)</td>
<td>Studies reporting what happens to the contaminant, rather than what happens to the organism. Studies describing the intermediary metabolism of the contaminant (e.g., radioactive tracer studies) without description of adverse effects.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>FOREIGN LANGUAGE</strong> (FL)</td>
<td>Studies in languages other than English.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>FOOD STUDIES</strong> (Food)</td>
<td>Food science studies conducted to improve production of food for human consumption.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>FUNGUS</strong> (Fungus)</td>
<td>Studies on fungus.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>GENE</strong> (Gene)</td>
<td>Studies of genotoxicity (chromosomal aberrations and mutagenicity).</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>HUMAN HEALTH</strong> (HHE)</td>
<td>Studies with human subjects.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>IMMUNOLOGY</strong> (IMM)</td>
<td>Studies on the effects of contaminants on immunological endpoints.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>INVERTEBRATE</strong> (Invert)</td>
<td>Studies that investigate the effects of contaminants on terrestrial invertebrates are excluded.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>IN VITRO</strong> (In Vit)</td>
<td><em>In vitro</em> studies, including exposure of cell cultures, excised tissues and/or excised organs.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>LEAD SHOT</strong> (Lead shot)</td>
<td>Studies administering lead shot as the exposure form. These studies are labeled separately for possible later retrieval and review.</td>
<td>Wildlife</td>
</tr>
<tr>
<td><strong>MEDIA</strong> (Media)</td>
<td>Authors must report that the study was conducted using natural or artificial soil. Studies conducted in pore water or any other aqueous phase (e.g., hydroponic solution), filter paper, petri dishes, manure, organic or histosols (e.g., peat muck, humus), are not considered suitable for use in defining soil screening levels.</td>
<td>Plants and Soil Invertebrates</td>
</tr>
<tr>
<td><strong>METHODS</strong> (Meth)</td>
<td>Studies reporting methods or methods development without usable toxicity test results for specific endpoints.</td>
<td>Wildlife</td>
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<tr>
<td><strong>MINERAL REQUIREMENTS</strong> (Mineral)</td>
<td>Studies examining the minerals required for better production of animals for human consumption, unless there is potential for adverse effects.</td>
<td>Wildlife</td>
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<tr>
<td><strong>MIXTURE</strong> (Mix)</td>
<td>Studies that report data for combinations of single toxicants (e.g. cadmium and copper) are excluded. Exposure in a field setting from contaminated natural soils or waste application to soil may be coded as Field Survey.</td>
<td>Wildlife</td>
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<td>Rejection Criteria</td>
<td>Description</td>
<td>Receptor</td>
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<td>MODELING (Model)</td>
<td>Studies reporting the use of existing data for modeling, i.e., no new organism toxicity data are reported. Studies which extrapolate effects based on known relationships between parameters and adverse effects.</td>
<td>Wildlife</td>
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<td>Plants and Soil Invertebrates</td>
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<td>NO CONTAMINANT OF CONCERN (No COC)</td>
<td>Studies that do not examine the toxicity of Eco-SSL contaminants of concern.</td>
<td>Wildlife</td>
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<td>Plants and Soil Invertebrates</td>
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<td>NO CONTROL (No Control)</td>
<td>Studies which lack a control or which have a control that is classified as invalid for derivation of TRVs.</td>
<td>Wildlife</td>
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<td>Plants and Soil Invertebrates</td>
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<tr>
<td>NO DATA (No Data)</td>
<td>Studies for which results are stated in text but no data is provided. Also refers to studies with insufficient data where results are reported for only one organism per exposure concentration or dose (wildlife).</td>
<td>Wildlife</td>
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<td>Plants and Soil Invertebrates</td>
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<tr>
<td>NO DOSE or CONC (No Dose)</td>
<td>Studies with no usable dose or concentration reported, or an insufficient number of doses/concentrations are used based on Eco-SSL SOPs. These are usually identified after examination of full paper. This includes studies which examine effects after exposure to contaminant ceases. This also includes studies where offspring are exposed in utero and/or lactation by doses to parents and then after weaning to similar concentrations as their parents. Dose cannot be determined.</td>
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<td>NO DURATION (No Dur)</td>
<td>Studies with no exposure duration. These are usually identified after examination of full paper.</td>
<td>Wildlife</td>
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<td>NO EFFECT (No Efct)</td>
<td>Studies with no relevant effect evaluated in a biological test species or data not reported for effect discussed.</td>
<td>Wildlife</td>
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<td>NO ORAL (No Oral)</td>
<td>Studies using non-oral routes of contaminant administration including intraperitoneal injection, other injection, inhalation, and dermal exposures.</td>
<td>Wildlife</td>
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<td>NO ORGANISM (No Org) or NO SPECIES</td>
<td>Studies that do not examine or test a viable organism (also see in vitro rejection category).</td>
<td>Wildlife</td>
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<td>Plants and Soil Invertebrates</td>
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<td>NOT AVAILABLE (Not Avail)</td>
<td>Papers that could not be located. Citation from electronic searches may be incorrect or the source is not readily available.</td>
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<td>NOT PRIMARY (Not Prim)</td>
<td>Papers that are not the original compilation and/or publication of the experimental data.</td>
<td>Wildlife</td>
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<td>NO TOXICANT (No Tox)</td>
<td>No toxicant used. Publications often report responses to changes in water or soil chemistry variables, e.g., pH or temperature. Such publications are not included.</td>
<td>Wildlife</td>
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<td>NO TOX DATA (No Tox Data)</td>
<td>Studies where toxicant used but no results reported that had a negative impact (plants and soil invertebrates).</td>
<td>Plants and Soil Invertebrates</td>
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<td>NUTRIENT (Nutrient)</td>
<td>Nutrition studies reporting no concentration related negative impact.</td>
<td>Plants and Soil Invertebrates</td>
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<td>NUTRIENT DEFICIENCY (Nut def)</td>
<td>Studies of the effects of nutrient deficiencies. Nutritional deficient diet is identified by the author. If reviewer is uncertain then the administrator should be consulted. Effects associated with added nutrients are coded.</td>
<td>Wildlife</td>
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<tr>
<td>NUTRITION (Nut)</td>
<td>Studies examining the best or minimum level of a chemical in the diet for improvement of health or maintenance of animals in captivity.</td>
<td>Wildlife</td>
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<tr>
<td>OTHER AMBIENT CONDITIONS (OAC)</td>
<td>Studies which examine other ambient conditions: pH, salinity, DO, UV, radiation, etc.</td>
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<td>Plants and Soil Invertebrates</td>
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<td>OIL (Oil)</td>
<td>Studies which examine the effects of oil and petroleum products.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<td>OM, pH (OM, pH)</td>
<td>Organic matter content of the test soil must be reported by the authors, but may be presented in one of the following ways; total organic carbon (TOC), particulate organic carbon (POC), organic carbon (OC), coarse particulate organic matter (CPOM), particulate organic matter (POM), ash free dry weight of soil, ash free dry mass of soil, percent organic matter, percent peat, loss on ignition (LOI), organic matter content (OMC). With the exception of studies on non-ionizing substances, the study must report the pH of the soil, and the soil pH should be within the range of $4$ and $8.5$. Studies that do not report pH or report pH outside this range are rejected.</td>
<td>Plants and Soil Invertebrates</td>
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<tr>
<td>ORGANIC METAL (Org Met)</td>
<td>Studies which examine the effects of organic metals. This includes tetraethyl lead, triethyl lead, chromium picolinate, phenylarsionic acid, roxarsone, 3-nitro-4-phenylarsionic acid, zinc phosphide, monomethylarsinic acid (MMA), dimethylarsinic acid (DMA), trimethylarsine oxide (TMAO), or arsenobetaine (AsBe) and other organo metallic fungicides. Metal acetates and methionines are not rejected and are evaluated.</td>
<td>Wildlife</td>
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<tr>
<td>LEAD BEHAVIOR OR HIGH DOSE MODELS (Pb Behav)</td>
<td>There are a high number of studies in the literature that expose rats or mice to high concentrations of lead in drinking water (0.1, 1 to 2% solutions) and then observe behavior in offspring, and/or pathology changes in the brain of the exposed dam and/or the progeny. Only a representative subset of these studies were coded. Behavior studies examining complex behavior (learned tasks) were also not coded.</td>
<td>Wildlife</td>
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<td>PHYSIOLOGY STUDIES (Phys)</td>
<td>Physiology studies where adverse effects are not associated with exposure to contaminants of concern.</td>
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<td>PLANT (Plant)</td>
<td>Studies of terrestrial plants are excluded.</td>
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<td>PRIMATE (Prim)</td>
<td>Primate studies are excluded.</td>
<td>Wildlife</td>
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<tr>
<td>PUBL AS (Publ as)</td>
<td>The author states that the information in this report has been published in another source. Data are recorded from only one source. The secondary citation is noted as Publ As.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>QSAR (QSAR)</td>
<td>Derivation of Quantitative Structure-Activity Relationships (QSAR) is a form of modeling. QSAR publications are rejected if raw toxicity data are not reported or if the toxicity data are published elsewhere as original data.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<tr>
<td>REGULATIONS (Reg)</td>
<td>Regulations and related publications that are not a primary source of data.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<tr>
<td>REVIEW (Rev)</td>
<td>Studies in which the data reported in the article are not primary data from research conducted by the author. The publication is a compilation of data published elsewhere. These publications are reviewed manually to identify other relevant literature.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<td>Rejection Criteria</td>
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<td>SEDIMENT CONC (Sed)</td>
<td>Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<tr>
<td>SCORE (Score)</td>
<td>Papers in which all studies had data evaluation scores at or lower then the acceptable cut-off (#10 of 18) for plants and soil invertebrates.</td>
<td>Plants and Soil Invertebrates</td>
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<tr>
<td>SEDIMENT CONC (Sed)</td>
<td>Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
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<tr>
<td>SLUDGE</td>
<td>Studies on the effects of ingestion of soils amended with sewage sludge.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>SOIL CONC (Soil)</td>
<td>Studies in which the only exposure concentration/dose reported is for the level of a toxicant in soil.</td>
<td>Wildlife</td>
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<tr>
<td>SPECIES</td>
<td>Studies in which the species of concern was not a terrestrial invertebrate or plant or mammal or bird.</td>
<td>Plants and Soil Invertebrates Wildlife</td>
</tr>
<tr>
<td>STRESSOR (QAC)</td>
<td>Studies examining the interaction of a stressor (e.g., radiation, heat, etc.) and the contaminant, where the effect of the contaminant alone cannot be isolated.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>SURVEY (Surv)</td>
<td>Studies reporting the toxicity of a contaminant in the field over a period of time. Often neither a duration nor an exposure concentration is reported.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>REPTILE OR AMPHIBIAN (Herp)</td>
<td>Studies on reptiles and amphibians. These papers flagged for possible later review.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>UNRELATED (Unrel)</td>
<td>Studies that are unrelated to contaminant exposure and response and/or the receptor groups of interest.</td>
<td>Wildlife</td>
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<tr>
<td>WATER QUALITY STUDY (Wqual)</td>
<td>Studies of water quality.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
<tr>
<td>YEAST (Yeast)</td>
<td>Studies of yeast.</td>
<td>Wildlife Plants and Soil Invertebrates</td>
</tr>
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Appendix 5-1

Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Trivalent Chromium

April 2008
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### Appendix 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV) Trivalent Chromium

#### Page 1 of 1

<table>
<thead>
<tr>
<th>Ref</th>
<th>Test Location</th>
<th>General Effect Group</th>
<th>Effect Type</th>
<th>Chemical Form</th>
<th>Dose Route</th>
<th>Route of Exposure</th>
<th>Age</th>
<th>Exposure Duration</th>
<th>Sex</th>
<th>Control Type</th>
<th>Body Weight in kg</th>
<th>Body Weight Reported?</th>
<th>Endpoint</th>
<th>Dose Quantification</th>
<th>Chemical form</th>
<th>Dose Route</th>
<th>Ref N.</th>
<th>Test Species</th>
<th>Conc/Dose Units</th>
<th>Wet Weight Reported?</th>
<th>Study NOAEL</th>
<th>Study LOAEL</th>
<th>NOAEL (mg/kg bw/day)</th>
<th>LOAEL (mg/kg bw/day)</th>
<th>Data Evaluation Score</th>
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The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).
Appendix 5-2

Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Hexavalent Chromium

April 2008
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## Appendix 5.2 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

### Hexavalent Chromium

#### Page 1 of 1

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The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).
Appendix 6-1

Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Trivalent Chromium

April 2008
### Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

**Trivalent Chromium**

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<th>Dose Route</th>
<th>Dose Route in kg or Dose Range</th>
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**Test Species**

- *Ovis aries* (sheep)
- *Sus scrofa* (pig)
- *Rattus norvegicus* (rat)
- *Mus musculus* (mouse)
- *Bos taurus* (cattle)
- *Rattus norvegicus* (rat)
- *Sus scrofa* (pig)
- *Rattus norvegicus* (rat)
- *Mus musculus* (mouse)
- *Bos taurus* (cattle)
- *Rattus norvegicus* (rat)
- *Sus scrofa* (pig)
- *Rattus norvegicus* (rat)
- *Mus musculus* (mouse)
- *Bos taurus* (cattle)
- *Rattus norvegicus* (rat)
- *Sus scrofa* (pig)
- *Rattus norvegicus* (rat)
- *Mus musculus* (mouse)
- *Bos taurus* (cattle)

**Conc/Dose Units**

- Wet Weight Reported?
- Method of Analyses
- Route of Exposure
- Exposure Duration
- Duration Units
- Age
- Lifestage
- Critical Lifestage?

**Study LOAEL**

- Ingestion Rate in kg or
- Dose Range
- NOAEL Dose (mg/kg/day)

**NOAEL Dose (mg/kg/day)**

- Endpoint

**Data Not Used to Derive Wildlife Toxicity Reference Value**

- *Eco-SSL for Chromium* April 2008

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Eco-SSL for Chromium

April 2008
### Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

#### Trivalent Chromium

| Batch # | Ref. N. | Chemical Form | MW% | Test Species | Phase # | # of Conc/Doses | Conc/Doses | Test Concentration | Applicability | Route of Exposure | Application Frequency | Test Conditions | NOAEL Dose (mg/kg/day) | LOAEL Dose (mg/kg/day) | Data Source | Dose Route | Test Concentration | Chemical form | Dose Quantification | Endpoint | NOAEL | LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL | Body Weight Reported? | Body Weight (kg) | Ingestion Rate Reported? | Ingestion Rate (kg or L/day) | Effect Type | Effect Measure | Response Site | Study NOAEL | Study LOAEL |
| 46 | 10473 | Bruckdorfer et al., 1971 | Chromium acetate | 100 | Rat (Rattus norvegicus) | 1 2 | 0/0.14 mg/d | N | na | ADL | U | DR | 2 | 9 w | 30 d | JV | M | C | Y | Lab | PHY | FD | 0.14 | N | 0.123 | N | 0.04952 | 0.266 | 10 | 10 | 3 | 3 | 3 | 2 | 5 | 1 | 10 | 10 | 10 | 10 | 10 |
| 47 | 10473 | Bruckdorfer et al., 1971 | Chromium acetate | 100 | Rat (Rattus norvegicus) | 1 2 | 0/0.14 mg/d | N | na | ADL | U | DR | 3 | 9 w | 30 d | JV | M | C | Y | Lab | ORW | SMIX | LI | 0.14 | N | 0.123 | N | 0.04952 | 0.266 | 10 | 10 | 3 | 3 | 3 | 2 | 5 | 1 | 10 | 10 | 10 | 10 | 10 |
| 48 | 10473 | Bruckdorfer et al., 1971 | Chromium acetate | 100 | Rat (Rattus norvegicus) | 1 2 | 0/0.14 mg/d | N | na | ADL | U | DR | 1 | 9 w | 30 d | JV | M | C | Y | Lab | GRO | BDWT | WO | 0.14 | N | 0.123 | N | 0.04952 | 0.266 | 10 | 10 | 3 | 3 | 3 | 2 | 5 | 1 | 10 | 10 | 10 | 10 | 10 |
| 51 | 14446 | Shroeder et al., 1963 | Trivalent chromium | 100 | Rat (Rattus norvegicus) | 1 2 | 0/5 mg/L | N | na | ADL | U | DR | 2 | 332 d | 28 d | JV | M | C | Y | Lab | MOR | SURV | WO | 5 | Y | 0.118 | N | 0.05730 | 1.44 | 10 | 10 | 4 | 4 | 4 | 1 | 10 | 10 | 10 | 10 | 10 | 10 |
| 52 | 3701 | Kanisawa and Schroeder, 1969 | Chromium acetate | 100 | Rat (Rattus norvegicus) | 1 2 | 0/5 mg/L | N | na | ADL | U | DR | 2 | 1189 d | 21 d | JV | B | C | Y | Lab | MOR | LFSP | WO | 5 | N | 0.248 | N | 0.02823 | 0.569 | 10 | 5 | 5 | 10 | 10 | 5 | 5 | 10 | 10 | 10 | 10 | 10 |
| 53 | 15198 | Cobo et al, 1995 | Organic Cr+3 | 100 | Rat (Rattus norvegicus) | 1 2 | 0/13.08 mg/L | N | na | ADL | M | DR | 1 8 w | NR | NR | JV | M | C | N | Lab | FDB | WCON | WO | 13.1 | Y | 0.338 | N | 0.03730 | 1.44 | 10 | 10 | 5 | 10 | 5 | 10 | 5 | 10 | 10 | 10 | 10 | 10 |
| 54 | 15198 | Cobo et al, 1995 | Chromium chloride hexahydrate | 19.514 | Rat (Rattus norvegicus) | 2 2 | 0/2.95 mg/g bw | N | na | ADL | M | DR | 2 | 8 w | NR | NR | JV | M | C | Y | Lab | FDB | WCON | WO | 2.95 | Y | 0.338 | N | 0.03730 | 5.65 | 10 | 5 | 5 | 10 | 5 | 10 | 5 | 10 | 10 | 10 | 10 | 10 |
| 55 | 3003 | Al-Hamood et al., 1998 | Chromium chloride 32.83 | 30 | Mouse (Mus musculus) | 1 4 | 0/200-2000 | mg/kg diet | N | na | ADL | U | FD | 1 | 35 d | 21 d | JV | M | C | Y | Lab | FDB | FCNS | WO | 400 | Y | 0.0259 | N | 0.02753 | 64.5 | 10 | 5 | 10 | 5 | 10 | 5 | 10 | 10 | 10 | 10 | 10 |
| 56 | 15506 | Schroeder, 1968 | Chromium chloride hexahydrate | 15 | Rat (Rattus norvegicus) | 1 2 | 0/3.596 mg/kg bw/d | N | na | ADL | U | DR | 1 | 487 d | 21-23 d | JV | M | C | Y | Lab | CHM | CHOL | SR | 3.596 | N | 0.235 | N | 0.02689 | 3.60 | 10 | 5 | 5 | 10 | 10 | 5 | 5 | 10 | 10 | 10 | 10 | 10 |

The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).
Appendix 6-2

Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Hexavalent Chromium

April 2008
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Appendix 6.2 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV) Hexavalent Chromium Page 1 of 2
### Appendix 6.2 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

#### Hexavalent Chromium

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The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).

**Eco-SSL for Chromium**

April 2008